



CLAIMS

1 1.(twice amended) A method for generating a moving haven boundary along a
2 voyage plan comprising the steps of:

3 establishing a width for said moving haven boundary;

4 creating rectangles centered on said voyage plan, said rectangles having
5 edges separated by said width and lengths equal to lengths of strait line portions
6 of said voyage plan; and

7 determining pie shaped areas between rectangles at waypoints of said
8 voyage plan, each of said pie shaped areas having an arc centered at a waypoint
9 and extending between vertices of rectangles on either side of said waypoint,

10 establishing said moving haven boundary with a polygonal line comprising
11 said edges and said arcs.

1 3.(amended) A method in accordance with claim 1 wherein said creating
2 rectangles step includes the steps of:

3 establishing a first rectangle having said width and a length substantially
4 equal to said specified distance;

5 establishing subsequent rectangles between adjacent waypoints, said
6 rectangles having said width and lengths substantially equal to distances
7 between said adjacent waypoints; and

8 establishing a last rectangle between said end point and a last waypoint.

1 6. A method in accordance with claim 1 wherein said arcs are approximated
2 with the steps of:

3 establishing a first vector between said given waypoint and a vertex of a
4 rectangle terminating at said given waypoint;

5 noting said vertex of said terminating rectangle as an end point of said first
6 vector;

7 establishing a second vector between said given waypoint and a vertex of a
8 rectangle originating at said given waypoint;

9 noting said vertex of said originating rectangle as an end point of said
10 second vector;

11 determining angular distance between said first and second vectors;

12 rotating said first vector by a selected angle to establish a third vector;

13 noting an end point of said third vector;

14 repeating rotations of a vector established by a previous rotation by said
15 selected angle until said angular distance between said first and second vectors
16 has been traversed;

17 noting end points of vectors determined by said repeating rotations; and

18 connecting said end points in a sequential manner to approximate said
19 arcs.

1 8.(twice amended) A method in accordance with claim 1 further including the
2 steps of:

3 forming buffer rectangles centered on said boundary having widths equal to
4 twice a selected distance from said boundary and lengths equal to distances
5 between vertices of said boundary;

6 forming buffer arcs between vertices of said buffer edges, said buffer
7 edges and said buffer arcs establishing polygonal lines internal and external to
8 said boundary; and

9 selecting said internal polygonal lines as a buffer boundary.

1 9. A method in accordance with claim 8 wherein said forming buffer arcs step
2 includes the steps of:

3 establishing a first vector between a vertex of an end edge of a selected
4 buffer rectangle and a point at which said end edge intersects said moving haven
5 boundary;

6 noting said vertex of said selected buffer rectangle as an end point of said
7 first vector;

8 establishing a second vector between a vertex of a leading edge of a buffer
9 rectangle next adjacent to said selected buffer rectangle and a point at which said
10 leading edge of said next adjacent rectangle intersects said boundary;

11 noting said vertex of said next adjacent rectangle as an end point of said
12 second vector;

13 determining angular distance between said first and second vectors;

14 rotating said first vector by a selected angle to establish a third vector;

15 noting an end point of said third vector;

16 repeating rotations of a vector established by a previous rotation by said
17 selected angle until said angular distance between said first and second vectors
18 has been traversed;

19 noting end points of vectors determined by said repeating rotations; and

20 connecting said end points in a sequential manner to approximate said
21 arcs.

1 **10. A method for generating a moving haven boundary along a voyage plan**
2 **comprising the steps of:**

3 **establishing an ordered list of points representing a polygonal line, said**
4 **polygonal line indicative of said voyage plan;**

5 **providing a width of said moving haven boundary;**

6 **generating sets of line segments between said points, each set**
7 **establishing a rectangle having said width and a length determined by a distance**
8 **between adjacent points;**

9 **determining intersecting line segments of adjacent rectangles;**

10 **creating arcs between said intersecting line segments about obtuse angles**
11 **at waypoints of said polygonal line ; and**

12 **forming said moving haven boundary utilizing said arcs and line segments**
13 **of said rectangles.**

1 **11. A method in accordance with claim 10 wherein said creating arcs step**
2 **includes the steps of:**

3 **establishing a first vector along a first line segment of first and second**
4 **intersecting line segments;**

5 **establishing a second vector along said second line segment;**

6 **determining angular distance between said first and second vectors;**

7 **rotating said first vector by a selected angle to establish a third vector;**

8 **repeating rotations of a vector established by a previous rotation by said**
9 **selected angle until said angular distance between said first and second vectors**
10 **has been traversed; and**

11 **connecting end points of said first, second, and third vectors and all vectors**
12 **created by said repeating rotations in to establish arc representative line**
13 **segments.**

1 12.(amended) A method in accordance with claim 11 wherein said forming step
2 includes the steps of:

3 combining said line segments and said arc representative line segments to
4 provide a set of combined line segments;

5 identifying a starting line segment from said set of combined line segments,
6 said starting line segment having a starting point and an ending point;

7 selecting a line segment intersecting said starting line segment in
8 accordance with a predetermined selection criteria, thereby providing a selected
9 line segment;

10 eliminating all line segments intersecting said starting segment other than
11 said selected line segment;

12 repeating said selecting step using said selected line segment as said
13 starting line segment meeting said selected criteria until all line segments have
14 been selected.

1 13. A method in accordance with claim 12 wherein said identifying step
2 includes the steps of:

3 selecting line segments in said set of combined line segments that are
4 entirely on or have a beginning on said moving haven boundary, thereby
5 establishing an acceptable set of starting line segments;

6 locating line segments in said acceptable set that have start points at a
7 preselected position in said moving haven, thereby providing a set of possible
8 starting line segments, should only one such line segment be in said acceptable
9 set, this line segment is chosen as a starting segment; and

10 choosing a line segment in said set of possible starting line segments that
11 points mostly in a predetermined direction, should more than one line segment be
12 in said acceptable set.

1 **14. A method in accordance with claim 12 wherein said selecting step includes**
2 **the steps:**

3 **finding all line segments intersecting said starting line segment, thereby**
4 **establishing a set of intersecting line segments;**

5 **dropping all line segments in said set of intersecting line segments**
6 **touching said starting point of said starting line;**

7 **eliminating all line segments in said set of intersecting line segments that**
8 **do not result in a turn of a predetermined direction;**

9 **determining points of intersection with said starting line segment of line**
10 **segments remaining in said set of intersecting line segments;**

11 **finding a point of intersection that is closest to said starting point of said**
12 **starting line, thereby establishing a closest point of intersection;**

13 **eliminating all line segments that do not include said closest point of**
14 **intersection;**

15 **selecting, from line segments remaining in said set of intersecting line**
16 **segments a line, a line segment having a turn angle in said predetermined**
17 **direction that is smaller than turn angles of all other line segments remaining in**
18 **said set of intersecting line segments.**

1 15. A method in accordance with claim 10 wherein said creating arcs step
2 includes the steps of:

3 establishing a first vector along a first line segment;

4 establishing a second vector along a line segment intersecting said first line
5 segment;

6 determining angular distance between said first and second vectors;

7 rotating said first vector by a selected angle to establish a third vector;

8 repeating rotations of a vector established by a previous rotation by said
9 selected angle until said angular distance between said first and second vectors
10 has been traversed;

11 connecting end points of said first, second, and third vectors and all vectors
12 created by said repeating rotations in a sequential manner to establish arc
13 representative line segments; and

14 including said arc representative line segments in said set of combined line
15 segments.

1 16.(amended) A method in accordance with claim 10 further including the step
2 of:

3 generating a buffer within said moving haven boundary having a boundary
4 at a selected distance from said moving haven boundary.

1 17.(amended) A method in accordance with claim 16 wherein said generating
2 step includes the steps of:

3 constructing buffer rectangles centered on said moving haven boundary
4 having widths equal to twice said selected distance and lengths equal to
5 distances between vertices of said moving haven boundary;

6 creating buffer arcs between vertices at buffer edges of said buffer
7 rectangles, said buffer edges and said buffer arcs establishing polygonal lines
8 internal and external to said boundary; and

9 selecting said internal polygonal lines as said buffer boundary.

1 18. A method in accordance with claim 17 wherein said creating buffer arcs
2 step includes the steps of:

3 establishing a first vector between a vertex of an end edge of a selected
4 buffer rectangle and a point at which said end edge intersects said moving haven
5 boundary;

6 noting said vertex of said selected buffer rectangle as an end point of said
7 first vector;

8 establishing a second vector between a vertex of a leading edge of a buffer
9 rectangle next adjacent to said selected buffer rectangle and a point at which a
10 leading edge of said next adjacent rectangle intersects said moving haven
11 boundary;

12 noting said vertex of said next adjacent rectangle as an end point of said
13 second vector;

14 determining angular distance between said first and second vectors;

15 rotating said first vector by a selected angle to establish a third vector;

16 noting an end point of said third vector;

17 repeating rotations of a vector established by a previous rotation by said
18 selected angle until said angular distance between said first and second vectors
19 has been traversed;

20 noting end points of vectors determined by said repeating rotations; and

21 connecting said end points in a sequential manner to approximate said
22 arcs.

1 19. A method in accordance with claim 17 wherein said constructing step
2 includes buffer start segment determining steps of:

3 selecting a line segment that is as least as long as all other line segments,
4 thereby providing a selected line segment;

5 finding a center of said selected line segment, thereby establishing a first
6 and second line segments, a first originating at said center and a second ending
7 at said center; and choosing one of said first and second line segments as said
8 buffer start segment.

1 20.(amended) An apparatus for providing a moving haven boundary along a
2 voyage plan comprising:

3 generator means for generating a polygonal line having line segments and
4 waypoints of said voyage plan;

5 rectangle means coupled to said generator means for establishing
6 rectangle line segments of rectangles along respective segments of said
7 polygonal line, each rectangle centered on said polygonal line of said voyage
8 plan, having a width equal to a preselected width of said moving haven and a
9 length equal to its respective line segment length;

10 arc means coupled to said rectangle means for providing an arc between a
11 trailing edge of a first rectangle and a leading edge of a second rectangle at a
12 selected waypoint, said leading and trailing edges intersecting at said selected
13 waypoint, said arc being represented by a series of arc line segments and formed
14 about an obtuse angle formed by said polygonal line at said selected waypoint;
15 and

16 boundary means coupled to said rectangle means and said arc means for
17 generating said moving haven boundary.

1 21. An apparatus in accordance with claim 20 where said boundary means
2 includes:

3 segment means coupled to said rectangle means and said arc means for
4 combining said rectangle line segments and said arc line segments, thereby
5 establishing a set of line segments;

6 start means coupled to said segment means for selecting a starting line
7 segment from said set of line segments;

8 intersect means coupled to said start means and said segment means for
9 selecting a line segment intersecting said starting line segment in accordance
10 with a predetermined selection criteria, thereby selecting a second line segment;
11 and

12 repeat means coupled to said intersect means and said segment means for
13 designating said second line segment to said intersect means as a starting line
14 segment and selecting a further line segment in accordance with said
15 predetermined selection criteria and thereafter utilizing said further line segment
16 as a starting line segment until all line segments in said segment means have
17 been utilized.

1 22. An apparatus in accordance with claim 21 wherein said start means
2 includes:

3 selector means coupled to said segment means for selecting line segments
4 from said set of line segments that are entirely on or have a beginning on said
5 moving haven boundary, thereby providing an acceptable starting line set;

6 locator means coupled to said selector means for providing line segments
7 in said acceptable starting line set having a starting point at a preselected
8 position, thereby providing a set of possible starting line segments; and

9 choice means coupled to said locator means for choosing a line segment in
10 said set of possible starting line segments that points mostly in a predetermined
11 direction.

1 23. An apparatus in accordance with claim 20 further including:

2 buffer rectangle means coupled to said boundary means for generating
3 rectangles about said boundary polygonal line;

4 buffer arc means coupled to said buffer rectangle means for generating
5 arcs between end edges of first rectangles and leading edges of second
6 rectangles; and

7 buffer polygonal line means coupled to said buffer rectangle means and
8 said buffer arc means for utilizing said rectangles and said arcs to establish a
9 buffer polygonal line within said moving haven boundary.

1 24. An apparatus in accordance with claim 23 wherein said buffer arc means
2 includes;

3 first vector means coupled to said buffer rectangle means for converting
4 said end edges to first vectors;

5 second vector means coupled to said buffer rectangle means for converting
6 said leading edges to second vectors;

7 angle means coupled to receive said first and second vectors for
8 determining angles between corresponding first and second vectors;

9 rotator means coupled to receive said first vectors and said angles
10 between corresponding first and second vectors for rotating said first vectors by
11 preselected angular increments until said angles have been traversed; and

12 end point means coupled to receive rotated vectors for noting end points
13 of vectors at each angular increment and coupling said end points to said buffer
14 polygonal line said end points and said rectangles are utilized to establish said
15 buffer polygonal line within said moving haven boundary.